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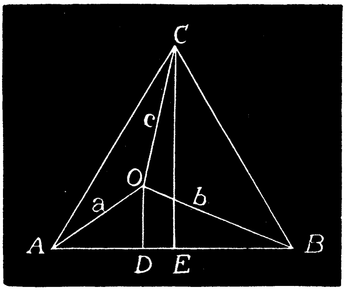
15. Proposed by SETH PRATT, C. E., Assyria, Michigan.

From a point in an equilateral triangle, the distances to the angles are, respectively, 20, 28, and 31 rods. Required a side of the triangle.

Solution by J. F. W. SCHEFFER, A. M., Hagerstown, Maryland.

To establish a general formula, we denote the three given lines by a, b, c, and the required side by x.



Let the perpendicular $OD=z$, $AD=y$, $CE=\frac{x}{2}\sqrt{3}$, $AE=\frac{x}{2}$. Now, we obviously have the three equations: $y^2+z^2=a^2$....(1), $(x-y)^2+z^2=b^2$....(2), and $\left(\frac{x}{2}\surd 3-z\right)^2+\left(\frac{x}{2}-y\right)^2=c^2$....(3).

Substituting the value of $y^2+z^2=a^2$ in (2), we get $x^2-2xy=b^2-a^2$, whence, $y=\frac{a^2-b^2+x^2}{2x}$....(4), and the value of $x^2+y^2+z^2$ from (2), in (3) and also (4) in (3), we obtain after a few easy reductions, $z=\frac{a^2+b^2-2c^2+x^2}{2x\sqrt{3}}$....(5). Substituting (4) and (5) in (1), we have without trouble the quadratic, $x^4-(a^2+b^2+c^2)x^2=a^2b^2+a^2c^2+b^2c^2-a^4-b^4-c^4$, whence

$$x^2=\tfrac{1}{2}[a^2+b^2+c^2+\sqrt{3}\surd\overline{2a^2b^2+2a^2c^2+2b^2c^2-a^4--b^4-c^4}]$$ or if we denote the area of the triangle whose sides are a, b, c, by $\triangle$, we obtain the elegant expression, $x^2=\frac{1}{2}[a^2+b^2+c^2+4\triangle\surd 3]$.

Substituting numerical values, we find $x^2=\frac{3}{2}[715+\surd 401557]=44.97+$. The minus value of the radical must be rejected for the case that O is without the triangle.

Also solved in various ways by *P. S. BERG, J. W. WATSON, H. C. WHITAKER, R. H. YOUNG, G. B. ZERR, L. B. FRAKER,* and the *PROPOSER.*

16. Proposed by COLMAN BANCROFT, Professor of Mathematics, Hiram College, Hiram, Ohio.

A traveler whose speed constantly increases in a geometrical progression passes A at 2 o'clock, B at 3:30, C at 4:30, and D at 6:18. At B he is moving at the rate of 12 miles per hour, and at C 18 miles. Find his rate at A and D, and the distance from A to each of the points B, C, and D.

Solution by H. C. WHITAKER, B. S., M. E., Professor of Mathematics, Manual Training School, Philadelphia, Pennsylvania.

Let a denote the rate at A, d the rate at D, r the rate of acceleration per hour. At the end of time t after 2 o'clock, the rate will be $a\left(1+\frac{r}{x}\right)^{tx}$, x being the number of times per hour the acceleration is added; this when x is infinite equals ae^{tr}; hence the equations $ae^{1.5r}=12$, $ae^{2.5r}=18$, $ae^{4.3r}=d$.

The distance $=\int_0^t ae^{tr}dt=\frac{a}{r}\left(e^{tr}-1\right)$.

Substituting for e its value 2.71828 and solving these equations,

$r=.405464$ miles per hour, $a=6.532$ miles per hour, $d=47.0148$ miles per hour, $AB=13.4857$ miles, $AC=28.29$ miles, and $AD=76.17$ miles.

Similarly solved by *Professor G. B. M. ZERR*, and solved under a different interpretation by *P. S. BERG*, *J. F. W. SCHEFFER*, and *J. W. WATSON.*

17. Proposed by G. B. M. ZERR, A. M., Principal of High School, Staunton, Virginia.

A sum of P dollars is loaned at r per cent. interest. At the end of the first year a payment of x dollars is made; and at the end of each following year the payment is made greater by m per cent. than the preceding year. If the sum is paid in n payments, find x.

Solution by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi, University P. O., Mississippi.

Let $R=1+r$, $M=1+m$.

Amt. owed after 1st. payment $=PR-x$.
.. .. .. 2nd. .. $=(PR-x)\mathrm{R}-xM=PR^2-xR-xM$.
.. .. .. 3rd. .. $=PR^3-xR^2-xMR-xM^2$.
.. .. .. 4th. .. $=PR^4-xR^3-xMR^2-xM^2R-xM^3$.

……

.. .. .. nth. .. $=PR^n-x(R^{n-1}+MR^{n-2}+M^2R^{n-3}+\dots.M^{n-2}$
$R+M^{n-1})$.

If n payments cancel the debt, this $=0$. The quantity in the parenthesis is a geometrical progression, the first term being R^{n-1}, the ratio $\frac{M}{R}$, the number of terms n.

$$\text{The sum is}\ \frac{R^{n-1}\left[\left(\frac{M}{R}\right)^n-1\right]}{\frac{M}{R}-1}=\frac{M^n-R^n}{M-R}.$$

$$\therefore\ \frac{M^n-R^n}{M-R}x=PR^n,$$

$$\text{and } x=\frac{M-R}{M^n-R^n}PR^n=\frac{(m-r)(1+r)^n}{(1+m)^n-(1+r)^n}P.$$

Also solved by *Professors SCHEFFER, WHITAKER*, and *ZERR.*

18. Proposed by WILLIAM E. HEAL, Member of the London Mathematical Society, Marion, Indiana.

Two railroad trains, lengths m and n, meet at a siding, length l. How shall the trains pass if $l<m<n$?

Solution by W. H. CRALLE, Department of Mathematics, Hogsett Academy, Danville, Kentucky.

Divide train m into sections l or less in length, and with its engine pull its first section on siding; then let engine of n take its train beyond the switch, attach to next section of m and back it till rear of n clears the switch; then let engine of m pull its first section above the switch; then let n back on to switch and beyond, leaving second section of m on switch; next, let engine of n pull its train again beyond switch; then engine of m backs first section into switch and pulls off the second section. This operation is repeated $\frac{m}{l}$ times